IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Applicant	:	Chih-Chien Liu		
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Title	:	HIGH DENSITY PLASMA CHEMICAL VAPOR DEPOSITION PROCESS		
Group Art Unit	:	1796		
Examiner	:	Sergent, Rabon A.		
Docket No.	:	20952.4002		
Customer No.	:	34313		

APPEAL BRIEF

On June 13, 2008, applicants timely filed a Notice of Appeal in this application, appealing the final rejection of claims 50-69, 72, 74, 80-88 and 90-102 set out in the Final Office Action dated March 13, 2008. Applicants timely filed an Appeal Brief with a petition for one month extension of time on September 11, 2008. The Patent Office mailed a Notification of Non-Compliant Appeal Brief to applicants' former counsel on September 23, 2008. This is applicants' corrected Appeal Brief further to the June 13, 2008 Notice of Appeal and the September 23, 2008 Notification.

Real Party in Interest

The real party in interest for this appeal is United Microelectronics Corporation, the assignee of the present application.

Related Appeals and Interferences

Applicants are not aware of any prior or pending appeals, interferences or judicial proceedings that are related to, directly affect or would be directly affected by or have a bearing on the Board's decision in the pending appeal.

Status of Claims

At the time of the Notice of Appeal, claims 50-69, 72, 74, 80-88 and 90-102 were pending in the application and were finally rejected. Applicants appealed the final rejection of all of claims 50-69, 72, 74, 80-88 and 90-102. Applicants filed an after final amendment on August 12, 2008 seeking the cancellation of claims 94 through 97. That amendment has been entered so that claims 50-69, 72, 74, 80-88, 90-93 and 98-102 are pending in the application and are finally rejected. Applicants appeal the final rejection of claims 50-69, 72, 74, 80-88, 90-93 and 98-102.

Claims 1-49, 70-71, 73, 75-79, 89 and 94-97 are canceled. Claims 50-69, 72, 74, 80-88, 90-93 and 98-102 are pending, finally rejected and are the subject of this appeal.

Status of Amendments

Applicants filed on August 12, 2008 an after final amendment canceling claims 94-97. That amendment has been entered so that claims 94-97 are canceled.

Summary of Claimed Subject Matter

The application includes three independent claims, claim 50, claim 61 and claim 80. The subject matter of the claims, as it relates to the finals rejections, is generally similar. The following illustrates first how claim 50 relates to the drawings and the specification. Additional discussion specific to claims 61 and 80 follows.

The application describes solutions to problems arising from "reduced design rules" or "smaller geometries" associated with technology advances in the manufacture of semiconductor integrated circuits. Application at page 2, line 16 through page 4, line 16. The problems to be solved included poor photolithography control and the inability to properly fill the gaps between conductive wiring lines with dielectric (insulating) materials. The application describes a process integration solution to these problems that includes the use of a specific deposition process, high density plasma chemical vapor deposition or HDPCVD, to fill the high aspect ratio gaps between wiring lines with dielectric material. Application at page 6, lines 16-27. The HDPCVD process combines a specific type of etching called sputtering with the process of depositing dielectric materials. HDPCVD provides a high level of control over the balance between etching and depositing to allow the process to deposit dielectric materials into small, high aspect ratio spaces between wiring lines.

The use of HDPCVD to fill the gaps between wiring lines can damage the wiring lines, reducing the reliability of both the wiring lines and the dielectric material between the wiring lines. Application at page 8, lines 28-30. The present inventors addressed this problem by providing a cap layer over each of the individual wiring lines prior to the HDPCVD process so that the cap layer protects the wiring lines from damage during the HDPCVD process. Application at page 9, lines 2-7. Importantly, the inventors identified materials that could be used as a cap layer that were dielectric (insulating) materials and that were effective to protect wiring lines from etching during HDPCVD, even when only a thin cap layer was used. Application at page 9, lines 7-10, page 10, lines 16-20.

The present inventors also improved on conventional photolithography by using two antireflective layers, one above the other, for the photolithography exposure process. The process described in the specification uses a first antireflective layer such as titanium nitride immediately adjacent the reflective layer of metal wiring material, Application at page 10, lines 4-7, and a second, antireflective layer such as one made of silicon oxynitride or silicon rich oxide directly on the first antireflective coating. Application at page 11, line 3-29. Using a first and a second antireflective layer reduces the occurrence of stray light and improves the process margins for photolithography.

The present inventors found that cap layer 28 can be used both to protect the wiring lines during HDPCVD and as one of the antireflective layers used in the application's preferred photolithographic processing.

FIGS. 1-4 Illustrate Claim 50

Paragraphs of claim 50 are copied, indented and italicized below and interspersed with a discussion of how the specification relates to claim 50. The paragraphs copied from claim 50 include reference numbers corresponding to structures illustrated in the application's drawings.

50. A method for forming conducting structures separated by gaps (36) on a substrate comprising:

providing a substrate (20) and a wiring line layer (24) above the substrate (20);

The first paragraph of the body of claim 50 is illustrated in FIG. 1 and described at least at page 9, lines 17-30. In the preferred embodiments, the wiring line layer 24 is aluminum or an aluminum alloy.

providing a conductive layer (26) on the wiring line layer (24);

This process of claim 50 is illustrated in FIG. 1 and described at least at page 10, lines 2-7 of the application, which identifies a "[p]rotective layer 26 that

is deposited on the wiring line layer 24." The cited passage states that "layer 26 is highly conductive," supporting the name "conductive layer" used in claim 50. Titanium nitride is one of the specific examples of a conductive layer provided in the specification at page 10, lines 10-11.

forming a cap layer (28) directly on the conductive layer (26), wherein the cap layer (28) has a particular thickness to create destructive interference and the cap layer (28) has a composition adapted to provide a graded index of refraction between said conductive layer (26) and a photoresist layer (30) during a photolithographic process, the photoresist layer (30) being formed on top of the cap layer (28);

The specification describes forming a cap layer 28 at page 10, lines 16-17. As shown in FIG. 1, the cap layer is formed in contact with and so "directly on" the conductive layer 26. See application at page 11, lines 25-29. The cap layer 28 is described as having a particular thickness to create destructive interference at application page 11, lines 4-15. Implementing a cap layer to provide a graded index of refraction is described at page 11, lines 23-29.

Finally, the process of forming a photoresist layer 30 on top of the cap layer 28 is illustrated in FIG. 1, where the photoresist layer 30 is shown, after having been patterned, as being on the cap layer 28. Application at page 10, lines 20-22.

etching through a portion of the cap layer (28) and portions of the conductive layer (26) and wiring line layer (24) to form wiring lines (24) separated by gaps (36), the wiring lines having a remaining portion of the cap layer (28) thereon; and

The etching process described in this part of claim 50 is illustrated in FIG. 2 and is described, for example, at page 10, lines 20-27.

depositing a dielectric material (38) on surfaces exposed by the etching process including exposed surfaces of the cap layer (28) to substantially fill the gaps (36) between the wiring lines (24), said dielectric material (38) including a layer formed by high density plasma chemical vapor deposition,

The depositing process is illustrated in FIGS. 3 and 4 and described at page 12, lines 16-30.

wherein the cap layer (28) acts to protect the wiring lines (24) and portions of the cap layer (28) are sacrificially removed during the process of depositing the dielectric material.

Finally, the function of the cap layer to protect the wiring lines during HDPCVD is discussed at application page 9, lines 2-7, page 12, lines 13-14 and lines 21-23.

FIGS. 1-4 also Illustrate Claim 61

As they relate to the issues on appeal, independent claims 61 and 80 are generally similar to claim 50. One of the appealed rejections relates to the existence of a written description that the cap layer 28 is "directly" on the conductive or protective layer 26. The rejection is based solely on whether there is a written description for the "directly" (in contact with) portion of the claim language. Different terminology is used in the three claims to identify the layer that the cap layer is "directly" on, but those aspects of the claims are not at issue. Consequently, the below discussion of claims 61 and 80 will address the specific limitations related to the written description rejection. A second part of the written description rejection relates to certain of the application's dependent claims, which are discussed below.

This appeal also addresses an indefiniteness rejection related to the use of the phrase "destructive interference." This language appears both in claim 50,

discussed above, and in claim 80. Claim 80's use of the phrase "destructive interference" is discussed below within the following discussion of the relevant paragraphs of claim 80.

Paragraphs of independent claim 61 are copied below, italicized, indented and with reference numbers inserted, prior to an illustration of how those paragraphs of claim 61 relate to the specification.

> *61. A method of forming conducting structures separated by gaps filled with dielectric material, the method comprising:*
>
> *providing a substrate (20) containing silicon, the substrate having a surface;*
>
> *forming a surface layer (22) comprising at least one material selected from the group consisting of titanium nitride, titanium silicide and a titanium tungsten alloy, the surface layer (22) disposed on the substrate (20) surface;*
>
> *forming a metal wiring layer (24) on the surface layer (22), the metal wiring layer (24) having an upper surface;*

The first three paragraphs of the body of claim 61 are illustrated in FIG. 1 and described at least at page 9, line 30 through page 10, line 3.

> *forming a protective layer (26) comprising at least one layer of a material selected from the group consisting of titanium nitride, titanium silicide and a titanium-tungsten alloy, the protective layer (26) disposed on the upper surface of the metal wiring layer (24), the protective layer (26) having a top surface;*

The "forming a protective layer" process of claim 61 is illustrated in FIG. 1 and described at least at page 10, lines 2-7 of the application, which identifies a "[p]rotective layer 26 that is deposited on the wiring line layer 24." The specification explains that the protective layer 26 can be the same material as

layer 22, page 10. lines 3-4, and explains that layer 22 can be the materials listed in this paragraph of claim 61. Application at page 9, lines 24-25.

forming a cap layer (28) comprising at least one material selected from the group consisting of an oxide, a nitride, a silicon-rich oxide, and an oxynitride, the cap layer (28) disposed directly on the top surface of the protective layer (26), wherein said cap layer (28) has a particular thickness to create destructive interference and a composition, the particular thickness and the composition adapted so that at least during a photolithographic process said cap layer creates destructive interference to reduce reflections;

The specification describes forming a cap layer 28 at page 10, lines 16-17. The specification identifies the group of materials that might be used as a cap layer at page 10, lines 16-20. As shown in FIG. 1, the cap layer is formed in contact with and so "directly" on the protective layer 26. See application at page 11, lines 25-29. The cap layer 28 is described as having a particular thickness to create destructive interference at application page 11, lines 4-15.

forming a patterned photoresist layer (30) on the cap layer (28), said patterned photoresist layer (30) covering selected portions of the cap layer (28) and exposing other portions of the cap layer (28);

etching the cap layer (28), the protective layer (26) and the metal wiring layer (24) to form the conductive structures (34) separated by gaps (36); and

The process of forming a photoresist layer 30 on top of the cap layer 28 is illustrated in FIG. 1, where the photoresist layer 30 is shown, after having been patterned, as being on the cap layer 28. Application at page 10, lines 20-22. The etching process described in this part of claim 61 is illustrated in FIG. 2 and is described, for example, at page 10, lines 20-27.

depositing dielectric material (38), including depositing at least a portion of dielectric material (38) using high density plasma chemical vapor deposition (HDPCVD) on surfaces exposed by the etching process including exposed surfaces of the cap layer (28), wherein the gaps (36) are substantially filled with the dielectric material (38), and

The depositing process is illustrated in FIGS. 3 and 4 and described at page 12, lines 16-30.

wherein the cap layer (28) acts to protect the wiring lines (36) and portions of the cap layer (28) are sacrificially removed during the process of forming the dielectric material (38) on surfaces exposed by the etching process, wherein the protective layer (26) comprises a material having a first dielectric constant and the cap layer (28) comprises an antireflective coating having a second dielectric constant, different from the first dielectric constant, and wherein the first dielectric constant and the second dielectric constant form a graded index of refraction.

The function of the cap layer to protect the wiring lines during HDPCVD is discussed at application page 9, lines 2-7, page 12, lines 13-14 and lines 21-23. The comparative dielectric constants and graded index of refraction are discussed at application page 11, lines 19-29.

FIGS. 1-4 also Illustrate Claim 80

The relevant paragraphs of claim 80 are copied below, italicized, indented and with reference numbers inserted, prior to an illustration of how those paragraphs of claim 80 relate to the specification.

80. A method for forming conducting structures (34) separated by gaps on a substrate comprising:

providing a substrate (20) and a wiring line layer (24) above the substrate (20);

The first paragraph of the body of claim 61 is illustrated in FIG. 1 and described at least at page 9, line 30 through page 10, line 3.

forming a first antireflective coating (26) above the wiring line layer (24);

The process of forming layer 26 is illustrated in FIG. 1 and described at least at page 10, lines 2-7 of the application. The specification explains that layer 26 can be a first antireflective coating, for example, at page 10, lines 7-10, which corresponds to this paragraph of claim 80.

forming a cap layer (28) adapted for protecting the wiring line layer (24) during a plasma based process, the cap layer (28) being situated directly on the first antireflective coating (26) and having a particular thickness to create destructive interference, wherein the cap layer (28) and the first antireflective coating (26) have different dielectric constants;

The specification describes forming a cap layer 28 at page 10, lines 16-17. The specification identifies the group of materials that might be used as a cap layer at page 10, lines 16-20. As shown in FIG. 1, the cap layer is formed in contact with and so "directly" on the protective layer 26. See application at page 11, lines 25-29. The cap layer 28 is described as having a particular thickness to create destructive interference at application page 11, lines 4-15. The specification states that the cap layer 28 and the first antireflective coating 26 can have different dielectric constants at page 11, lines 25-29.

forming a photoresist layer (30) directly on top of the cap layer;
patterning the photoresist layer (30) during a lithographic process;

etching through portions of the first antireflective coating, a portion of the cap layer (28) and a portion of the wiring line layer (24) to form wiring lines (34) separated by high aspect ratio gaps (36); and

The process of forming a photoresist layer 30 on top of the cap layer 28 is illustrated in FIG. 1, where the photoresist layer 30 is shown, after having been patterned, as being on the cap layer 28. Application at page 10, lines 20-22. The etching process described in this part of claim 80 is illustrated in FIG. 2 and is described, for example, at page 10, lines 20-27.

depositing a dielectric material (38) to substantially fill the gaps (36), including using a HDPCVD process at least until any high aspect ratio gaps (36) are substantially filled, followed by a different plasma process that fills any remaining portion of said gaps and results in a planarized surface,

The depositing process is illustrated in FIGS. 3 and 4 and described at page 12, lines 16-30.

wherein the cap layer (28) and the first antireflective coating (26) form a graded change in an index of refraction.

The dielectric constants and the graded index of refraction created by the cap layer and the antireflective coating are discussed at application page 11, lines 19-29.

Illustration of Dependent Claims 51, 52, 53, 55, 60, 68 and 69

The Final Office Action listed a set of claims for which "applicants have failed to indicate where support exists for the amendments." That statement is the entire basis for the Final Office Action's written description rejection of claims 51, 52, 53, 55, 60, 68 and 69. This summary of the claimed subject matter now

addresses each of these dependent claims in turn. Each of the claims is presented in the manner discussed above prior to a discussion of how the claim relates to the specification.

51. The method of claim 50, wherein the cap layer (28) is used as a hard mask during etching of the wiring line (24) layer prior to when portions of the cap layer (28) are sacrificially removed during the process of depositing the dielectric material (38).

The use of the cap layer as a hard mask for etching is discussed at least at page 12, lines 1-12. FIG. 2 illustrates the results of the etching process. That HDPCVD processing is performed after etching is described at page 12, lines 14-16. The sacrificial removal of the cap layer during HDPCVD (as part of the cap layer protecting the wiring line) is discussed at application page 9, lines 5-7.

52. The method of claim 50, wherein the cap layer (28) comprises an antireflective coating that operates by destructive interference, and said conductive layer (26) comprises a layer of titanium nitride.

The cap layer 28 is described as functioning as an antireflective coating through destructive interference at application page 11, lines 4-15 and at page 16, line 23. Titanium nitride is one of the specific examples of a conductive layer 26 provided in the specification at page 10, lines 2-11.

53. The method of claim 50, wherein the cap layer (28) comprises an oxynitride antireflective coating and said conductive layer (26) comprises a metallic layer comprising titanium above a layer (24) comprising aluminum.

This claim is illustrated in FIG. 1. The cap layer 28 is described as functioning as an antireflective coating at application page 11, lines 4-15 and at

page 16, line 23. The specification describes using an oxynitride as the cap layer at page 10, lines 16-17. Titanium nitride is one of the specific examples of a conductive layer 26 provided in the specification at page 10, lines 2-11. The wiring line layer 24 is described as aluminum at page 9, line 29 to page 10, line 2.

55. The method of claim 50, wherein the remaining portion of the cap layer (28) on at least one wiring line (24) has a rectangular shape in cross section prior to when portions of the cap laver (28) are sacrificially removed during the process of depositing the dielectric material (38).

This claim is illustrated in FIG. 2, which shows the remaining portion 28 of cap layer 28 is rectangular in cross section after etching. That HDPCVD processing is performed after etching is described at page 12, lines 14-16. The sacrificial removal of the cap layer during HDPCVD (as part of the cap layer protecting the wiring line during HDPCVD) is discussed at application page 9, lines 5-7.

60. The method of claim 50, wherein the remaining portion of the cap layer (48, 58, 68, 78) is shaped using etching prior to the depositing a dielectric material (38) to have a shape that reduces redeposition of the cap layer into the gaps during the high density plasma chemical vapor deposition process.

This claim is illustrated in FIGS. 5-8, which show different shapes of cap layers 48, 58, 68, 78 that can alter the etching characteristics of the HDPCVD process. Application at page 13, lines 9-30. Etching the cap layer into different shapes to minimize the amount of material redeposited is discussed at page 13, lines 22-27. That HDPCVD processing is performed after cap layer etching is described at page 12, lines 14-16.

68. The method of claim 61, further comprising removing the patterned photoresist layer (30) prior to depositing the dielectric material (38) using high density plasma chemical vapor deposition.

This claim corresponds to the description at page 12, lines 14-16 and corresponds to a point in the process between FIG. 1, which shows the patterned photoresist 30, and FIG. 2, which shows the stage of processing after the photoresist pattern 30 is removed.

69. The method of claim 61, wherein the cap layer (28) protects the underlying wiring layer (24) throughout the depositing the dielectric material (38) using high density plasma chemical vapor deposition.

This claim is illustrated in FIGS. 2-4, which shows the integrated circuit in cross section before any deposition of the dielectric material (FIG. 2), at an intermediate stage (FIG. 3) and after depositing the dielectric material 38 and a second layer of dielectric material 40 (FIG. 4). FIGS. 2-4 show that the cap layer 28 is present on top of the wiring layer 24 throughout the process of depositing the dielectric layer 38. That the layer 38 is deposited by high density plasma chemical vapor deposition (HDPCVD) is described at page 12, lines 13-30. Finally, the cap layer is described as protecting the wiring line at page 12, lines 13-14.

Grounds of Rejection to Be Reviewed

1. Whether the Final Office Action properly rejects independent claims 50, 61 and 80 under the written description requirement of 35 U.S.C. § 112, ¶ 1.
2. Whether the Final Office Action properly rejects dependent claims 51, 52, 53, 55, 60, 68 and 69 under the written description requirement of 35 U.S.C. § 112, ¶ 1.
3. Whether the Final Office Action properly rejects independent claims 50 and 80 as indefinite under 35 U.S.C. § 112, ¶ 2.

ARGUMENT

Applicants submit that the rejections set forth in the Final Office Action of March 13, 2008 are improper. The application fully supports the claims erroneously rejected on written description grounds. The indefiniteness rejection is similarly in error, as the claim language identified in the rejection is well defined in the context of the claim. Instead of being indefinite, the rejected claims use well understood terms commonly used in the fields of optics and photolithography.

1. The Final Office Action Wrongly Rejects Claims 50, 61 and 80 on Written Description Grounds

The Final Office Action rejects claims 50, 61 and 80 as lacking a written description in the specification for a cap layer (28) being "directly" on a protective layer (26) or conductive layer (26). Applicants respectfully disagree, in that the very first drawing of the patent application shows layer 28 formed "directly" on – in contact with – the layer 26 and the specification provides an exactly consistent description at Application page 10, lines 16-17 and page 11, lines 25-29. Claim 50 can be taken as a representative claim for purposes of this rejection.

The Final Office Action rejects claim 50 for the use of the word "directly" in that portion of claim 50's language related to the cap layer being disposed directly on the top surface of the protective layer. The rejection at page 2 of the action states as follows:

> "Firstly, with respect to claims 50, 61, and 80, adequate support has not been found for the amendments specifying that the cap layer is 'directly on' the specified layer of each claim. Applicants have stated that support for the amendment is set forth at page 11, lines 9-11; however the examiner find [*sic*] no such support for these amendments at this location."

As a preliminary matter, applicants made other amendments to claim 50 that were supported by the citation to page 11, lines 9-11. It is true that citation does not provide support for the "directly on" limitation of claim 50. Applicants hardly

considered it necessary to waste the Examiner's time by stating the obvious observation that layer 28 is directly on layer 26 in the illustration of FIG. 1.

Vas-Cath Inc. v. Mahurkar, 935 F.2d 1555, 19 USPQ2d 1111 (Fed. Cir. 1991) provides a thorough discussion of the written description requirement of 35 U.S.C. § 112, ¶ 1. The *Vas-Cath* case sets out the following test for determining compliance with written description requirement: Does the application, including the drawings, convey with reasonable clarity to those of ordinary skill in the art that the applicants were in possession of whatever is now claimed? *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, 1563-64, 19 USPQ2d 1111, 1117 (Fed. Cir. 1991), *see also* Manual of Patent Examining Procedure § 2163.02 (Rev. 5, Aug. 2006) (citing *Vas-Cath v. Mahurkar* with approval).

The only portion of claim 50 that gives rise to the written description rejection is the use of the word "directly." Before the most recent amendment, claim 50 recited in pertinent part, "forming a cap layer on the conductive layer." This language was not rejected as lacking written description. The amendment that gave rise to the rejection added the word "directly" so that this portion of claim 50 recited "forming a cap layer directly on the conductive layer" (emphasis added). Thus, it is only the addition of the word "directly" that gives rise to this rejection. Original FIG. 1 of the application shows that cap layer 28 is formed in physical contact with the top surface of the protective layer 26 and so provides a written description that layer 28 is directly on layer 26.

The Federal Circuit's *Vas-Cath* case makes it clear that a patent's drawings alone may provide a written description for a claim. "[T]he proper test is whether the drawings conveyed with reasonable clarity to those of ordinary skill that [the inventor] had in fact invented the [invention] recited in those claims." *Vas-Cath*, 935 F.2d at --, 19 USPQ2d at 1119. This test is particularly easy to apply to the facts of the written rejection of claim 50. FIG. 1, by itself, shows that the cap layer 28 is disposed "directly" on the top surface of the protective layer 26 and provides a full written description of the "directly" on language that is the subject of the written description rejection of claim 50.

Of course, the application provides more support for the use of the word "directly" in claim 50. The application explains: "Cap layer 28 ... is deposited over the protective layer 26." Application at page 10, lines 16-17. Anyone of ordinary skill in the art of integrated circuit fabrication would understand that statement to describe a process that results in cap layer 28 being in physical contact with – directly on – protective layer 26. See also Application at page 11, lines 25-29.

There is no need for the application to have used the word "directly" if one of ordinary skill in the art would have reasonably understood that layer 28 was "directly" on layer 26. See Manual of Patent Examining Procedure § 2163.02 at page (Rev. 5, Aug. 2006). It is abundantly clear from the drawings and the specification that the applicants had possession of a process that formed a cap layer 28 disposed directly on a protective layer 26. Consequently, both the drawings and the specification provide a written description of the use of the word "directly" in claim 50. The rejection of claim 50 is consequently in error and should be reversed.

Applicants submit that claim 50 can be taken as representative of this rejection of claims 50, 61 and 80 on this point. Because the rejection of claim 50 is in error, the rejections of claims 61 and 80 are similarly in error and should also be reversed.

2. The Written Description Rejection of the Dependent Claims Does Not Meet Patent Office Rules or Controlling Precedent for Such Rejections

The Final Office Action states its written description rejection of dependent claims 51, 52, 53, 55, 60, 68 and 69 as follows:

> "Secondly, applicants have failed to indicate where support exists for the amendments to claims 51, 52, 53, 55, 60, 68, and 69. It is requested that applicants indicate where this subject matter is supported."

Final Office Action at page 2.

Applicants note that this passage, which is the only explanation of this rejection, does not suggest that anything is deficient in the specification's support for claims 51, 52, 53, 55, 60, 68 and 69. Nevertheless, the Final Office Action states that these dependent claims are rejected as lacking written description under 35 U.S.C. § 112, ¶ 1. Applicants respectfully disagree with the Final Office Action's rejection of dependent claims 51, 52, 53, 55, 60, 68 and 69. The original application provides a full and immediately apparent written description of each of these claims.

The MPEP states the legal standard for evaluating the written description requirement as, "An objective standard for determining compliance with the written description requirement is, 'does the description clearly allow persons of ordinary skill in the art to recognize that he or she invented what is claimed.'" Manual of Patent Examining Procedure 2163.02 (Rev. 4, Aug. 2006), *quoting In re Gosteli*, 872 F.2d 1008, 1012, 10 USPQ2d 1614, 1618 (Fed. Cir. 1989). The MPEP further explains that, "The subject matter of the claim need not be described literally (i.e., using the same terms or *in haec verba*) in order for the disclosure to satisfy the description requirement." Manual of Patent Examining Procedure 2163.02 (Rev. 4, Aug. 2006). Applicants agree that this is an accurate statement of the relevant legal authority. When this standard is applied to the specification with respect to the rejected dependent claims, it is clear that the Final Office Action's rejection is improper and should be reversed with respect to each of the dependent claims.

Since the above-quoted explanation of this rejection is directed to the new language introduced to the claims by applicants' December 20, 2007 amendments, the written description support for those amendments is set out below, following the headings. For convenience, each claim is reproduced following its respective heading, with the language added in the most recent amendment indicated by underlining. Reference numerals are included in the claims for further clarity and convenience.

A. The Final Rejection of Claim 68 on Written Description Grounds Is Erroneous and should be Reversed.

68. The method of claim 61, further comprising removing the patterned photoresist layer (30) prior to depositing the dielectric material (38) using high density plasma chemical vapor deposition.

The Final Office Action's rejection of claim 68 may be the best illustration of why the action's written description rejections are improper and must be reversed. Prior to the December 20, 2007 amendment, claim 68 recited as follows:

68. The method of claim 61, further comprising removing the patterned photoresist layer (30) prior to forming a layer of high density plasma chemical vapor deposition (HDPCVD) dielectric material (38).

What the December 20, 2007 amendment did to claim 68 was to delete the parenthetical "HDPCVD" and to change the claim wording from forming a layer of HDPCVD dielectric material to depositing the dielectric material by HDPCVD. Applicants view the amended claim 68 to have clearer antecedent relationship to independent claim 61 than the prior phrasing of claim 68. There is no reason why the December 20, 2007 amendment to claim 68, which is entirely consistent with the earlier wording of claim 68, could make claim 68 unpatentable for lack of written description in the application. The Final Office Action provides no explanation of what is missing from the specification with respect to the amendment to claim 68.

The original application provides a written description of claim 68 and specifically of the language "depositing the dielectric material using" added to claim 68 by the amendment of December 20, 2007. At page 12, lines 14-27, the original application states,

"After ... resist layer 30 is removed ... [a]n HDPCVD step is then carried out to form layer 38. Fig. 3 shows an early stage of the deposition of HDPCVD layer 38. ... The HDPCVD of layer 38 is performed until the gap

36 is substantially filled with a material that is preferably high density oxide ...."

Thus, the application explains that the resist layer is removed prior to performing HDPCVD ("[a]fter ... resist layer 30 is removed ... [a]n HDPCVD step is then carried out") and provides written description support for the claim language "removing the patterned photoresist layer (30) prior to [HDPCVD]." And the application at page 8, lines 17-20, states:

> "Another advantage of the use of HDPCVD to deposit intermetal dielectrics is that it is generally not necessary ... to densify the deposited dielectric material...."

There can be no serious question that the application provides a written description for the "depositing the dielectric material using" language added to claim 68 by the December 20, 2007 amendment. Applicants ask that the final rejection of claim 68 on written description grounds be reversed.

Claim 68 is a good example of why the Final Office Action's written rejection of the dependent claims are improper and should be withdrawn. The other rejected dependent claims are similarly erroneously rejected and are now discussed in numerical order.

B. The Final Rejection of Claim 51 on Written Description Grounds Is Erroneous and should be Reversed.

51. The method of claim 50, wherein the cap layer (28) is used as a hard mask during etching of the wiring line (24) layer prior to when portions of the cap layer (28) are sacrificially removed during the process of depositing the dielectric material (38).

The original application provides a written description of the language added to claim 51 by the December 20, 2007 amendment and indicated by underlining in the above copy of claim 51. The use of the cap layer as a hard mask for etching is discussed at least at page 12, lines 1-12. FIG. 2 illustrates

the results of the wiring line etching process. FIG. 3, which follows FIG. 2 in the processing, shows a portion of the cap layer 28 sacrificially removed during an initial portion of depositing the dielectric material 38 using high density chemical vapor deposition. Consequently, FIGS. 2 and 3 show that etching the wiring line is performed prior to when the cap layer is sacrificially removed during HDPCVD of layer 38.

As discussed in detail above, the drawings of a patent application can provide a written description for what is claimed. *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, --, 19 USPQ2d 1111, 1119 (Fed. Cir. 1991), *see also* Manual of Patent Examining Procedure § 2163.02 (Rev. 5, Aug. 2006) ("An applicant shows possession of the claimed invention by describing the claimed invention with all of its limitations using such means as ... figures, diagrams ...."). Consequently, the sequence of FIGS. 2 and 3 provides a written description of the language added to claim 51 by the amendment of December 20, 2007. That is, FIG. 2 shows the completion of the process of etching the wiring line layer in which layer 28 is used as a hard mask. FIG. 3 shows a point after the sacrificial removal of the corners of the originally rectangular-in-cross-section portions of the cap layer 28 during high density plasma chemical vapor deposition. It is readily apparent to those of ordinary skill that FIG. 2 is prior to the steps used to create what is shown in FIG. 3, so that these two drawings provide a complete written description of the language added to claim 51 by the amendment of December 20, 2007.

The text of the original application provides a further written description of the language added to claim 51 by the December 20, 2007 amendment. The application explains that etching the wiring line layer is performed before high density plasma chemical vapor deposition at page 12, lines 4-16:

> "[T]he cap layer 28 acts as a mask during the second etch step. ... After the etching is completed ... [a]n HDPCVD step is then carried out to form layer 38."

D. The Final Rejection of Claim 53 on Written Description Grounds Is Erroneous and Should be Reversed.

53. The method of claim 50, wherein the cap layer (28) comprises an oxynitride antireflective coating and said conductive layer (26) comprises a metallic layer comprising titanium above a layer (24) comprising aluminum.

As with the other independent and dependent claims discussed here, the original application provides a written description of the language added to claim 53 by the amendment of December 20, 2007. The application describes the cap layer 28 as functioning as an antireflective coating at page 11, lines 4-15 and at page 16, line 23 (original claim 11 recites, "wherein the cap layer is an antireflective coating"). The application describes using an oxynitride as the cap layer at page 10, lines 16-17 ("[c]ap layer 28 ... is ... silicon oxide, silicon nitride or oxynitride). Titanium nitride is one of the specific examples of a conductive layer 26 provided in the specification at page 10, lines 2-11. Therefore, the specification provides written description support for the conductive layer being "a metallic layer comprising titanium." The wiring line layer 24 is described as aluminum at page 9, line 29 to page 10, line 2. FIG. 1 shows that the conductive layer 26 is above layer 24.

The application consequently provides a written description of the language added to claim 53 by the amendment of December 20, 2007 so that the Final Office Action's written description rejection of claim 53 should be reversed.

E. The Final Rejection o f Claim 55 on Written Description Grounds Is Erroneous and should be Reversed.

55. The method of claim 50, wherein the remaining portion of the cap layer (28) on at least one wiring line (24) has a rectangular shape in cross section prior to when portions of the cap laver (28) are sacrificially removed during the process of depositing the dielectric material (38).

The original application provides a written description of the language added to claim 55 by the December 20, 2007 amendment and indicated by underlining in the above copy of claim 55. Claim 55 is illustrated in pertinent part by FIG. 2, which shows the remaining portions 28 of cap layer 28 are rectangular in cross section after etching the wiring line layer 24. FIG. 3, which follows FIG. 2 in the processing, shows top corner portions of the cap layer 28 sacrificially removed during an initial portion of depositing the dielectric material 38 using high density chemical vapor deposition.

As discussed in detail above, the drawings of a patent application can provide a written description for what is claimed. *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, --, 19 USPQ2d 1111, 1119 (Fed. Cir. 1991), *see also* Manual of Patent Examining Procedure § 2163.02 (Rev. 5, Aug. 2006) ("An applicant shows possession of the claimed invention by describing the claimed invention with all of its limitations using such means as ... figures, diagrams ...."). Consequently, the sequence of FIGS. 2 and 3 provides a written description of the language added to claim 55 by the amendment of December 20, 2007. That is, FIG. 2 shows a stage in the process where the portion of the cap layer 28 is rectangular in cross section. FIG. 3 shows a point after the sacrificial removal of the corners of the originally rectangular-in-cross-section portions of the cap layer 28 during high density plasma chemical vapor deposition. It is readily apparent to those of ordinary skill that FIG. 2 is prior to the steps used to create what is shown in FIG. 3, so that these two drawings provide a complete written description of the language added to claim 55 by the amendment of December 20, 2007.

In addition, the text of the original application provides an independent written description of the language added to claim 55 by the December 20, 2007 amendment. The application explains that etching the cap layer to form the structure shown in FIG. 2 is performed before high density plasma chemical vapor deposition at page 12, lines 4-16:

> "The first etch step etches through the portions of the cap layer that are not covered by photoresist. ... [T]he cap layer 28 acts as a mask during

the second etch step. ... After the etching is completed ... [a]n HDPCVD step is then carried out to form layer 38."

The original application explains that portions of the cap layer may be sacrificially removed during the HDPCVD process used to deposit the dielectric material 38 at page 9, lines 5-7:

"The cap layer may be sacrificially etched during the HDPCVD processing and protects the underlying metal wiring line from undesirable etching during the dielectric deposition process."

The application provides a written description of claim 55 and of the language added to claim 55 by the amendment of December 20, 2007. Independent written descriptions can be found in the drawings and in the text of the application. The Final Office Action's written description rejection of claim 55 should be reversed.

F. The Final Rejection of Claim 60 on Written Description Grounds Is Erroneous and should be Reversed.

60. The method of claim 50, wherein the remaining portion of the cap layer (48, 58, 68, 78) is shaped using etching prior to the depositing a dielectric material (38) to have a shape that reduces redeposition of the cap layer into the gaps during the high density plasma chemical vapor deposition process.

The application provides a full written description of the language added to claim 60 by the amendment of December 20, 2007. The above discussions of claims 51 and 55 identify the written description that etching the cap layer occurs prior to depositing the dielectric material 38. What is different between claim 60 and claims 51 and 55, is that claim 60 is specific to the process variations illustrated in FIGS. 5-8 with respect to the "shaped using etching" portion of claim 60. Claim 60 is otherwise broader than claims 51 and 60.

The application provides a written description that the etching shown in FIG. 2 occurs prior to depositing the dielectric material 38:

> "The first etch step etches through the portions of the cap layer that are not covered by photoresist. ... [T]he cap layer 28 acts as a mask during the second etch step. ... After the etching is completed ... [a]n HDPCVD step is then carried out to form layer 38." Application at page 12, lines 4-16.

The application explains that the shaping used to create the different shapes of cap layers 48, 58, 68, 78 shown in FIGS. 5-8 is performed as an alternative to the process that yields FIG. 2. Application at page 6, lines 1-2 and at page 13, lines 9-30. This, with the quoted language above, establishes a written description for the language added to claim 60 by the most recent amendment.

Additional written description that shaping the cap layer is performed prior to high density plasma chemical vapor deposition of dielectric material 38 is provided at page 13, lines 28-30: "Providing the capping layer with a similar faceted shape (such as that illustrated in Fig. 8) prior to the HDPCVD shape [*sic*, process] may provide certain advantages in the process."

The application provides a written description of the language added to claim 60 by the amendment of December 20, 2007. The Final Office Action's written description rejection of claim 60 should be reversed.

G. The Final Rejection of Claim 69 on Written Description Grounds Is Erroneous and should be Reversed.

> 69. The method of claim 61, wherein the cap layer (28) protects the underlying wiring layer (24) throughout the depositing the dielectric material (38) using high density plasma chemical vapor deposition.

The claim language added to claim 69 through the amendment of December 20, 2007 (indicated by underlining in the above copy of claim 69) finds written description support in FIGS. 2-4. FIGS. 2-4 show the integrated circuit in cross section before any deposition of the dielectric material (FIG. 2), at an

intermediate stage (FIG. 3) and after depositing the dielectric material 38 and a second layer of dielectric material 40 (FIG. 4). FIGS. 2-4 show that the cap layer 28 is present on top of the wiring layer 24 throughout the process of depositing the dielectric layer 38. *See Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, --, 19 USPQ2d 1111, 1119 (Fed. Cir. 1991) (the drawings of a patent application alone can provide a written description for what is claimed), *see also* Manual of Patent Examining Procedure § 2163.02 (Rev. 5, Aug. 2006) ("An applicant shows possession of the claimed invention by describing the claimed invention with all of its limitations using such means as ... figures, diagrams ...."). That the layer 38 is deposited by high density plasma chemical vapor deposition (HDPCVD) is described at application page 12, lines 13-30. Finally, the cap layer is described as protecting the wiring line at application page 12, lines 13-14 ("[T]he cap layer 28 may also act as a wiring line top corner protector during subsequent HDPCVD processing....").

Thus, the original application provides a written description for the language added to claim 69 by the amendment dated December 20, 2007. The Final Office Action's written description rejection of claim 69 should be reversed.

3. The Indefiniteness Rejection of Claims 50 and 80 Is Erroneously Based on Reading "Destructive Interference" Out of Context and Should be Reversed

The Final Office Action rejects claims 50 and 80 for their use of the claim language "destructive interference." Specifically, the Final Office Action states, "With respect to claims 50 and 80, applicants have referred to the creation of destructive interference; however, it is unclear with respect to what is being interfered with and/or when or under what conditions interference is occurring." Final Office Action at page 2. Applicants submit that this rejection is incorrect at least because the rejection is based on reading the phrase "destructive interference" out of context. The rejection should be reversed. Applicants submit that claim 50 can be taken as representative of claims 50 and 80 for the purposes of this rejection.

The MPEP aptly describes the purpose of 35 U.S.C. § 112, ¶ 2 definiteness requirement is "to ensure that the scope of the claims is clear so the public is informed of the boundaries of what constitutes infringement ...." Manual of Patent Examining Procedure § 2173 (Rev. 5, Aug. 2006). The standard for determining definiteness "is whether the claim meets the threshold requirements of clarity and precision, not whether more suitable language or modes of expression are available. ... The essential inquiry pertaining to this requirement is whether the claims set out and circumscribe a particular subject matter with a reasonable degree of clarity and particularity." *Id.* at § 2173.02. Applying these principles to claim 50 shows that claim 50 fully complies with the requirements of 35 U.S.C. § 112, ¶ 2.

The starting point for evaluating definiteness under 35 U.S.C. § 112, ¶ 2 is the language of the claim. Claim 50 recites in pertinent part (with reference numerals inserted):

> 50. ... forming a cap layer (28) directly on the conductive layer (26), wherein the cap layer (28) has a particular thickness to create destructive interference and the cap layer (28) has a composition adapted to provide a graded index of refraction between said conductive layer (26) and a photoresist layer (30) during a photolithographic process, the photoresist layer (30) being formed on top of the cap layer (28)...."

Claim 50 includes the language "wherein the cap layer has a particular thickness to create destructive interference." This language defines characteristics of the cap layer. That is, the cap layer "has a particular thickness" and that thickness is such that the cap layer can "create destructive interference."

The Final Office Action accepts, as it must, that the phrase "the cap layer has a particular thickness" is definite and comports with 35 U.S.C. § 112, ¶ 2. The term "particular thickness" is a broad one that may refer to any thickness of the cap layer. Still, the bounds defined by the claim language "the cap layer has a particular thickness" are defined and the phrase is definite. Adding the concept that the cap layer has a particular thickness that also creates destructive interference defines the cap layer more precisely than the simpler term "the cap

layer has a particular thickness." It follows naturally that the phrase "the cap layer has a particular thickness to create destructive interference" is a more precise definition of the cap layer than the simpler partial phrase "the cap layer has a particular thickness."

"Destructive interference" is an optical phenomenon well known to those of ordinary skill in the art of photolithography. The application explains destructive interference from page 11, line 3 to line 17. That section of the application states, in part,

> "[T]he cap layer may be used as a quarter wave plate in order to prevent light from passing through the cap layer and reflecting back up to the photoresist layer .... [T]he quarter wave plate creates destructive interference to prevent light from reflecting up to the photoresist layer. Those of ordinary skill will appreciate that the particular thickness of layer 28 to be provided when layer 28 has its preferred function as a quarter wave plate is different for different materials. ... It should be appreciated that minor variations from the optimal thickness of layer 28 as a quarter waveplate will typically be effective in reducing reflectivity, although less effectively." Application at page 11, lines 3-17.

The term "destructive interference" is sufficiently basic as to appear in numerous college textbooks such as Hecht & Zajac, Optics (1979) at page 278; Marion & Heald, Classical Electromagnetic Radiation (2d ed., 1980) at page 348; and Feynman, et al., The Feynman Lectures on Physics, Vol. I (1963) at page 29-7. Moreover, the implications of the term are apparent to anyone of ordinary skill. "Destructive interference" is known to be a phenomenon observed using collimated (i.e., uniform in direction), monochromatic light (i.e., uniform in wavelength) of the type typically used in photolithography. Layers that can produce destructive interference are uniform in thickness and in their optical properties. Because of the need for uniformity, layers that produce destructive interference tend to be thin but that can vary with the level of uniformity exhibited by the layer.

Following the illustration in the specification and the understanding of those of ordinary skill in the art, what the term "destructive interference" adds to the phrase "the cap layer has a particular thickness to create destructive interference" is that the cap layer has a sufficiently uniform "particular thickness" to allow destructive interference to occur. Consequently, the claim language "the cap layer has a particular thickness to create destructive interference" is more definite and in better compliance with 35 U.S.C. § 112, ¶ 2 than the simpler claim language "the cap layer has a particular thickness."

It is worth noting that the Final Office Action does not reject all uses of the term "destructive interference" in the currently pending claims. Claim 61 recites the phrase "destructive interference," and the Final Office Action does not reject claim 61 as indefinite. The use of the phrase "destructive interference" should not be considered to render claims 50 and 80 indefinite, either. The final rejection of claims 50 and 80 as indefinite should be withdrawn.

Even if the claim reading of the Final Office Action's indefiniteness rejection is accepted, claim 50 is definite. Referring back to the indefiniteness rejection of the Final Office Action, it appears that the Final Office Action reads claim 50 as requiring that "destructive interference" involving the cap layer occur at some point in time. Specifically, the Final Office Action states, "With respect to claims 50 and 80, applicants have referred to the creation of destructive interference; however, it is unclear with respect to what is being interfered with and/or when or under what conditions interference is occurring." Final Office Action at page 2. As discussed above, applicants believe the Final Office Action's reading of "the cap layer has a particular thickness to create destructive interference" is incorrect. Applicants believe that this phrase is defining characteristics of the cap layer and is not reciting a method step.

Still, if the apparent construction of the Final Office Action is accepted and applied here, claim 50 remains definite. If, as assumed by the Final Office Action, "creates destructive interference" is a method step, then that step is well defined and one of ordinary skill in the art would know if it occurred in a particular process. An engineer running or analyzing a semiconductor process flow could,

through experimental observations or calculations, determine if "destructive interference" was created by the cap layer at some point in the semiconductor process flow set out in claim 50. The Final Office Action does not suggest otherwise. If the ordinary engineer can determine the scope of a claim, nothing more is required for a claim to be definite and comply with 35 U.S.C. § 112, ¶ 2. Manual of Patent Examining Procedure § 2173 (Rev. 5, Aug. 2006) (The standard for determining definiteness "is whether the claim meets the threshold requirements of clarity and precision, not whether more suitable language or modes of expression are available. ... The essential inquiry pertaining to this requirement is whether the claims set out and circumscribe a particular subject matter with a reasonable degree of clarity and particularity.").

Whether under what applicants believe to be the correct claim reading discussed above or under the claim reading adopted by the Final Office Action, the scope of claim 50 can readily be determined by one of ordinary skill in the art. Consequently, "the cap layer has a particular thickness to create destructive interference" is definite and claim 50 complies with 35 U.S.C. § 112, ¶ 2.

Applicants submit that claim 50 can be taken as representative of this rejection of claims 50 and 80 for indefiniteness. Because the rejection of claim 50 is in error, the indefiniteness rejection of claim 80 is similarly in error and should also be reversed.

Conclusion

Applicants have demonstrated that the final rejection of claims 50-69, 72, 74, 80-88, 90-93 and 98-102 is improper and that claims 50-69, 72, 74, 80-88, 90-93 and 98-102 should be allowed. Applicants request that the Final Office Action of March 13, 2008 be reversed and the present application be allowed.

The Commissioner is authorized to charge any fee which may be required in connection with this Appeal Brief to deposit account No. 15-0665.

Respectfully submitted,

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1-49. Canceled.

50. A method for forming conducting structures separated by gaps on a substrate comprising:

providing a substrate and a wiring line layer above the substrate;

providing a conductive layer on the wiring line layer;

forming a cap layer directly on the conductive layer, wherein the cap layer has a particular thickness to create destructive interference and the cap layer has a composition adapted to provide a graded index of refraction between said conductive layer and a photoresist layer during a photolithographic process, the photoresist layer being formed on top of the cap layer;

etching through a portion of the cap layer and portions of the conductive layer and wiring line layer to form wiring lines separated by gaps, the wiring lines having a remaining portion of the cap layer thereon; and

depositing a dielectric material on surfaces exposed by the etching process including exposed surfaces of the cap layer to substantially fill the gaps between the wiring lines, said dielectric material including a layer formed by high density plasma chemical vapor deposition,

wherein the cap layer acts to protect the wiring lines and portions of the cap layer are sacrificially removed during the process of depositing the dielectric material.

51. The method of claim 50, wherein the cap layer is used as a hard mask during etching of the wiring line layer prior to when portions of the cap layer are sacrificially removed during the process of depositing the dielectric material.

52. The method of claim 50, wherein the cap layer comprises an antireflective coating that operates by destructive interference, and said conductive layer comprises a layer of titanium nitride.

53. The method of claim 50, wherein the cap layer comprises an oxynitride antireflective coating and said conductive layer comprises a metallic layer comprising titanium above a layer comprising aluminum.

54. The method of claim 50, wherein the cap layer comprises a material selected from the group consisting of silicon oxide, silicon nitride, or silicon oxynitride.

55. The method of claim 50, wherein the remaining portion of the cap layer on at least one wiring line has a rectangular shape in cross section prior to when portions of the cap laver are sacrificially removed during the process of depositing the dielectric material.

56. The method of claim 50, wherein the remaining portion of the cap layer on at least one wiring line has a trapezoidal shape in cross section.

57. The method of claim 56, wherein the trapezoidal shape includes top and bottom surfaces parallel to one another and side surfaces that extend inwardly from the bottom surface to the top surface.

58. The method of claim 50, wherein the remaining portion of the cap layer on at least one wiring line has a triangular shape in cross section.

59. The method of claim 50, wherein the remaining portion of the cap layer on at least one wiring line has, in cross section, a rectangular shape having its upper corners etched away.

60. The method of claim 50, wherein the remaining portion of the cap layer is shaped using etching prior to the depositing a dielectric material to have a shape that reduces redeposition of the cap layer into the gaps during the high density plasma chemical vapor deposition process.

61. A method of forming conducting structures separated by gaps filled with dielectric material, the method comprising:

providing a substrate containing silicon, the substrate having a surface;

forming a surface layer comprising at least one material selected from the group consisting of titanium nitride, titanium silicide and a titanium tungsten alloy, the surface layer disposed on the substrate surface;

forming a metal wiring layer on the surface layer, the metal wiring layer having an upper surface;

forming a protective layer comprising at least one layer of a material selected from the group consisting of titanium nitride, titanium silicide and a titanium-tungsten alloy, the protective layer disposed on the upper surface of the metal wiring layer, the protective layer having a top surface;

forming a cap layer comprising at least one material selected from the group consisting of an oxide, a nitride, a silicon-rich oxide, and an oxynitride, the cap layer disposed directly on the top surface of the protective layer, wherein said cap layer has a particular thickness to create destructive interference and a

composition, the particular thickness and the composition adapted so that at least during a photolithographic process said cap layer creates destructive interference to reduce reflections;

forming a patterned photoresist layer on the cap layer, said patterned photoresist layer covering selected portions of the cap layer and exposing other portions of the cap layer;

etching the cap layer, the protective layer and the metal wiring layer to form the conductive structures separated by gaps; and

depositing dielectric material, including depositing at least a portion of dielectric material using high density plasma chemical vapor deposition (HDPCVD) on surfaces exposed by the etching process including exposed surfaces of the cap layer, wherein the gaps are substantially filled with the dielectric material, and

wherein the cap layer acts to protect the wiring lines and portions of the cap layer are sacrificially removed during the process of forming the dielectric material on surfaces exposed by the etching process, wherein the protective layer comprises a material having a first dielectric constant and the cap layer comprises an antireflective coating having a second dielectric constant, different from the first dielectric constant, and wherein the first dielectric constant and the second dielectric constant form a graded index of refraction.

62. The method of claim 61, wherein the cap layer is used as a hard mask during etching of the wiring line layer.

63. The method of claim 61, wherein portions of the cap layer are etched during the depositing dielectric material using high density plasma chemical vapor deposition.

64. The method of claim 61, wherein the cap layer comprises a material selected from the group consisting of silicon oxide, silicon nitride, or silicon oxynitride.

65. The method of claim 61, wherein the depositing dielectric material using high density plasma chemical vapor deposition substantially fills the gaps between the conductive structures.

66. The method of claim 61, wherein the dielectric material is deposited using high density plasma chemical vapor deposition onto a surface of the substrate, onto side surfaces of the metal wiring layer, the surface layer, the protective layer, and the cap layer.

67. The method of claim 61, wherein the dielectric material is deposited using high density plasma chemical vapor deposition onto an upper surface of the cap layer.

68. The method of claim 61, further comprising removing the patterned photoresist layer prior to depositing the dielectric material using high density plasma chemical vapor deposition.

69. The method of claim 61, wherein the cap layer protects the underlying wiring layer throughout the depositing the dielectric material using high density plasma chemical vapor deposition.

70-71. Canceled.

72. The method of claim 61, wherein the graded index of refraction reduces boundary reflections between the protective layer and the antireflective coating.

73. Canceled.

74. The method of claim 61, wherein twice the particular thickness of the cap layer is an odd number of the wavelengths of the exposure light, compensating for the dielectric constant of the cap layer.

75-79. Canceled.

80. A method for forming conducting structures separated by gaps on a substrate comprising:

providing a substrate and a wiring line layer above the substrate;

forming a first antireflective coating above the wiring line layer;

forming a cap layer adapted for protecting the wiring line layer during a plasma based process, the cap layer being situated directly on the first antireflective coating and having a particular thickness to create destructive interference, wherein the cap layer and the first antireflective coating have different dielectric constants;

forming a photoresist layer directly on top of the cap layer;

patterning the photoresist layer during a lithographic process;

etching through portions of the first antireflective coating, a portion of the cap layer and a portion of the wiring line layer to form wiring lines separated by high aspect ratio gaps; and

depositing a dielectric material to substantially fill the gaps, including using a HDPCVD process at least until any high aspect ratio gaps are substantially

filled, followed by a different plasma process that fills any remaining portion of said gaps and results in a planarized surface,

wherein the cap layer and the first antireflective coating form a graded change in an index of refraction.

81. The method of claim 80, wherein the first antireflective coating absorbs portions of radiation applied during the lithographic process.

82. The method of claim 80, wherein the cap layer also functions as a mask during the etching process.

83. The method of claim 80, wherein an additional portion of the cap layer is etched while the cap layer protects the wiring line layer during the HDPCVD process.

84. The method of claim 80, further comprising forming a surface layer between the substrate and the wiring line layer.

85. The method of claim 80, further comprising the step of removing the cap layer before depositing a dielectric material within the gaps.

86. The method of claim 80, wherein portions of the cap layer are removed and portions of the cap layer act as a mask during the etching of the first antireflective coating and the wiring line layer.

87. The method of claim 80, wherein after etching each wiring line has a portion of the cap layer thereon, the portion of a cap layer on each wiring line having a cross-sectional shape selected from the group consisting of a rectangle, a triangle, trapezoid, and a rectangle having its upper corners etched away.

88. The method of claim 80 wherein the cap layer and the first antireflective coating are used as a hard mask.

89. Canceled.

90. The method of claim 80 wherein the cap layer has a dielectric constant that is closer to a dielectric constant of the first antireflective coating than to the photoresist mask layer dielectric constant.

91. The method of claim 80, wherein said different plasma process deposits material at a higher rate than the HDPCVD process.

92. The method of claim 80, wherein said different plasma process is a PECVD oxide process.

93. The method of claim 80, wherein the cap layer comprises silicon, oxygen, and nitrogen.

94-97. Canceled, by after final amendment submitted concurrently with the opening brief in this appeal.

98. The method of claim 50, wherein the cap layer comprises silicon-rich oxide.

99. The method of claim 80, wherein the cap layer comprises silicon-rich oxide.

100. The method of claim 50, wherein a portion of the substrate is etched when the wiring lines are etched.

101. The method of claim 61, wherein a portion of the substrate is etched when the wiring lines are etched.

None.

Related Proceedings Appendix

None.

Applicants note that U.S. Patent No. 6,117,345, which issued from application Serial No. 08/958,460, was the subject of an administrative proceeding before the United States International Trade Commission, including a final determination that certain claims of U.S. Patent No. 6,117,345 were shown invalid over prior art. The final determination is of record to the present application. However, because the proceeding before the U.S.I.T.C. is not a Patent Office proceeding and because the U.S.I.T.C. is not a court, the U.S.I.T.C. proceeding is not a "related proceeding" to be listed in this section.